

Example 2 - Greenhouse Gas PSD Applicability Example Determination Calculations

Natural Gas Compressor Stations

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Example Scenario 2: New Natural Gas Compressor Station

STEP #1 – Identify Emitting Units

- Three (3) 800 Brake Horsepower (bhp) Compressor Engines
- Three (3) Reboilers

(Note: Other emitting units typically exist at a natural gas compressor station but only these two emitting units are included for this example.)

STEP #2 – Calculate Potential to Emit (PTE)

For this example, let's assume the facility PTE for each criteria pollutant is as follows:

PM₁₀ = 0.81 tons per year (tpy)
CO = 27.06 tpy
NO_x = 348 tpy
SO_x = 0.06 tpy
VOC = 4.66 tpy

STEP #3 – Determine PSD Applicability for Criteria Pollutants

Based on the PTE calculations above, is the facility subject to PSD for a criteria pollutant(s)? Because the facility is not a listed source and NO_x emissions (348 tpy) are greater than 250 tpy, a PSD analysis for NO_x would be required.

STEP #4 – Determine PSD Applicability for GHGs and Calculate PTE for GHGs

In this step we will need to calculate the potential emissions for the applicable GHGs. GHGs listed in the final rule include carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆). (Note: Some of these GHGs have a higher global warming potential (GWP) than the others so they are expressed in CO₂ equivalents (CO₂e) in order to help standardize the evaluation of GHGs and determine if a facility is covered by a permitting program.)

For this hypothetical example, however, we will focus on the stationary combustion sources (e.g., as the natural gas compressor engines and reboilers) in which CO₂, CH₄, and N₂O are the GHGs that are formed during the combustion process.

In general, there two basic approaches that may be used to estimate greenhouse gases from a combustion source.

- 1.) Direct measurement (e.g., CEMS).
- 2.) Calculation based method.
 - a.) Fuel analysis approach.
 - b.) Generalized approach (e.g., emission factors).

For this example scenario, let's focus on a generalized approach using emission factors for stationary combustion sources.

Generalized Approach

Example Greenhouse Gas Emission Factors for Natural Gas Combustion:

- 116.87 lb/MMBtu for CO₂
- 0.011014 lb/MMBtu for CH₄
- 0.000022 lb/MMBtu for N₂O

(Source: Inventory of U.S. Greenhouse Gas Emissions and Sinks, April 2008. U.S. EPA.)

(Note: Emission factors can likely be obtained from a variety of sources so make sure you reference and/or justify them, as appropriate.)

Global Warming Potentials:

- Carbon dioxide (CO₂) = 1
- Methane (CH₄) = 21
- Nitrous oxide (N₂O) = 310

(Source: Table A-1, Title 40, Part 98, Subpart A)

Miscellaneous Assumptions:

1. Natural Gas Compressor Engines Fuel Consumption = 8500 Btu/hp-hr @ Maximum Design Capacity
2. Reboilers Fuel Consumption = 256 MBtu/hr @ Maximum Design Capacity
3. Natural Gas Heat Value = 1020 Btu/scf

Calculations:

The GHG emissions calculations will be completed by calculating the CO₂ emissions and converting the CH₄ and N₂O to their CO₂e and summing the CO₂e for each GHG.

Emitting Unit #1: Natural Gas Compressor Engines

Fuel Consumption:

800-hp * 8500 Btu/hp-hr * 1/1020 Btu/scf * 1 Mscf/1000 scf = 6.67 Mscf/hr = 160 Mscf/day =
58,400 Mscf/yr = 58.4 MMscf/yr

Heat Produced:

58.4 MMscf/yr * 1020 Btu/scf * 1,000,000 scf/1MMscf = 59,568,000,000 Btu/yr = 59,568 MMBtu/yr

Carbon Dioxide (CO₂):

116.87 lb/MMBtu * 59,568 MMBtu/yr * 1 ton/2000 lb = 3,480 tons/yr of CO₂ * 3 engines = 10,443 tons/yr of CO₂

Methane (CH₄):

0.011014 lb/MMBtu * 59,568 MMBtu/yr * 1 ton/2000 lb = 0.328 tons/yr CH₄ * 3 engines = 0.984 tons/yr CH₄

Nitrous Oxide (N₂O):

0.000022 lb/MMBtu 59,568 MMBtu/yr * 1 ton/2000 lb = 0.00066 tons/yr N₂O * 3 engines = 0.00196 tons/yr N₂O

Total GHG Emissions for Compressor Engines on a Mass Basis:

10,443 tons/yr of CO₂ + 0.984 tons/yr CH₄ + 0.00196 tons/yr N₂O = **10,444 tons/yr of GHGs on a mass basis**

Total Emissions of CO₂e:

Carbon Dioxide (CO₂):

116.87 lb/MMBtu * 59,568 MMBtu/yr * 1 ton/2000 lb = 3,480 tons/yr of CO₂ * 3 engines = 10,443 tons/yr of CO₂

Methane (CO₂e):

CH₄ in tons/yr * GWP for CH₄ = CO₂e for CH₄
0.984 tons/yr CH₄ * 21 = 20.66 tons/yr CO₂e

Nitrous Oxide (CO₂e):

N₂O in tons/yr * GWP for N₂O = CO₂e for N₂O
0.00196 tons/yr N₂O * 310 = 0.61 tons/yr CO₂e

Sum the Total CO₂e Emissions:

CO₂e emissions for the compressor engines = 10,443 tons/yr CO₂ + 20.66 tons/yr CH₄ (CO₂e) + 0.61 tons/yr N₂O (CO₂e) = **10,464 tons/yr CO₂e**

Emitting Unit #2: Reboilers

Fuel Consumption/Heat Produced:

Reboiler Fuel Consumption = 256 MBtu/hr @ Maximum Design Capacity
256 MBtu/hr = 6,144 MBtu/day = 2,242,560 MBtu/yr = 2,242.56 MMBtu/yr

Carbon Dioxide (CO₂):

116.87 lb/MMBtu * 2,242.56 MMBtu/yr * 1 ton/2000 lb = 131.04 tons/yr of CO₂ * 3 reboilers =
393.13 tons/yr of CO₂

Methane (CH₄):

0.011014 lb/MMBtu * 2,242.56 MMBtu/yr * 1 ton/2000 lb = 0.012 tons/yr CH₄ * 3 reboilers =
0.037 tons/yr CH₄

Nitrous Oxide (N₂O):

0.000022 lb/MMBtu * 2,242.56 MMBtu/yr * 1 ton/2000 lb = 0.000025 tons/yr N₂O * 3 engines =
0.000074 tons/yr N₂O

Total GHG Emissions for Reboilers on a Mass Basis:

393.13 tons/yr of CO₂ + 0.037 tons/yr CH₄ + 0.000074 tons/yr N₂O = **393 tons/yr** of GHGs
on a mass basis for the reboilers

Carbon Dioxide (CO₂):

116.87 lb/MMBtu * 2,242.56 MMBtu/yr * 1 ton/2000 lb = 131.04 tons/yr of CO₂ * 3 reboilers =
393.13 tons/yr of CO₂

Methane (CO₂e):

CH₄ in tons/yr * GWP for CH₄ = CO₂e for CH₄
0.037 tons/yr CH₄ * 21 = 0.78 tons/yr CO₂e

Nitrous Oxide (CO₂e):

N₂O in tons/yr * GWP for N₂O = CO₂e for N₂O
0.000074 tons/yr N₂O * 310 = 0.023 tons/yr CO₂e

Sum the Total CO₂e Emissions for the Reboilers:

393.13 tons/yr CO₂ + 0.78 tons/yr CH₄ (CO₂e) + 0.023 tons/yr N₂O (CO₂e) = **393.93 tons/yr CO₂e**

Sum the Total CO₂e Emissions for the Compressor Engines and Reboilers:

10,464 tons/yr + 394 tons/yr = 10,857 tons/yr CO₂e

Applicability PSD Analysis Overview:

Question #1: Does this permit action result in an increase of any criteria pollutant above PSD threshold levels?

Yes, potential NO_x emissions are greater than the 250 tpy threshold so a PSD analysis for NO_x would be required.

Question #2: Does this permit action have GHG emissions above the PSD threshold on a mass basis?

Yes, the GHGs emissions on a mass basis are approximately 10,837 tpy.

Question #3: Does this permit action have CO₂e emissions above the PSD threshold?

No, the CO₂e emissions (10,857 tpy) were less than the 75,000 tpy CO₂e threshold.

While a PSD review would be required for NO_x, the answer to Questions #2 and #3 must both be “Yes” for GHGs to undergo a PSD review. Because the total CO₂e for the new facility was less than the 75,000 tpy threshold for GHGs, no PSD review would be required for GHGs.

Title V Applicability Analysis/Overview:

Question #1: Are the potential emissions of any criteria pollutant greater than 100 tons per year?

Yes.

Question #2: Are the potential emissions of GHGs greater than 100 tons per year?

Yes.

Question #3: Are the potential emissions as CO₂e greater than 100,000 tons per year?

No

If the answer to Questions #1, #2, and #3 is “Yes”, a Title V permit action to address GHGs are described in the following scenarios.

- A department decision occurring before January 2, 2011, would not require GHGs to be addressed in the Title V permit.
- A department decision occurring after January 2, 2011, must address GHGs in the Title V permit.
- A department decision occurring after July 1, 2011, must address GHGs in the Title V permit.

If the answer to Questions #2 and #3 is “Yes”, a Title V permit action to address GHGs are shown as follows:

- A department decision occurring before January 2, 2011, would not require GHGs to be addressed in the Title V permit.
- A department decision occurring after January 2, 2011, would not require GHGs to be addressed in the Title V permit.
- A department decision occurring after July 1, 2011, would require GHGs to be addressed in the Title V permit.